

What is claimed is:

1. A method for processing bit symbols generated by a data source, in particular a video, still image or audio source, comprising the following steps:

constructing a plurality of bit-planes using the bit symbols generated by the data source, each bit-plane comprising a plurality of bit-plane symbols;

scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols;

encoding the binary string of the bit-plane symbols using a statistical model, wherein the statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the data source, wherein the Laplacian probability distribution function is defined by

$$f(x) = \frac{e^{-|x|\sqrt{\frac{2}{\sigma^2}}}}{\sqrt{2\sigma^2}}$$

wherein σ is the standard deviation of the Laplacian probability distribution function.

2. The method according to claim 1, wherein the encoding of the binary string of bit-plane symbols is performed by an entropy encoder.

3. The method according to claim 2, wherein an arithmetic encoder is used as the entropy encoder.

5 4. The method according to claim 1, wherein a probability assignment to each bit-plane symbol is determined based on the Laplacian probability distribution function and is used to determine the statistical model for encoding the binary string of bit-plane symbols.

10 5. The method according to claim 4, wherein the probability assignment to the bit-plane symbol is determined by

$$P_j = 1 - \left(1 + e^{-2^j \sqrt{\frac{2}{\sigma^2}}} \right)^{-1}, \quad j = M-1, M-2, \dots$$

15 wherein

P_j is the probability assignment to the bit-plane symbol, and

j is the bit-plane.

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6. The method according to claim 1, wherein a probability assignment to each bit-plane symbol is determined based on previously encoded bit-plane symbols.

25 7. The method according to claim 6, wherein the probability assignment to the bit-plane symbol is determined by

$$P_j = \frac{N_a}{N} P_j^{N_a} + \left(1 - \frac{N_a}{N} \right) P_j^{ML}$$

wherein

P_j is the probability assignment to the current bit-plane symbol,

5 j is the bit-plane,

N_a is the number of bit-plane symbols coded until the end of the previous bit-plane,

N is the number of bit-plane symbols coded until the current bit-plane symbol,

10 P_j^{Na} is the estimation of P_j after observing N_a bit-plane symbols,

P_j^{ML} is the maximum likelihood estimation of P_j for the current bit-plane and is defined by

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$$P_j^{ML} = \frac{\sum_{i=1}^{N-N_a} b_{i,j}}{N - N_a}$$

wherein $b_{i,j}$ is the bit-plane symbol.

20 8. The method according to claim 7, wherein the estimation of P_j after observing N_a bit-plane symbols, P_j^{Na} , is updated by

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$$P_j^{N_a} = \frac{\sqrt{P_{j+1}^{N_a}}}{\sqrt{1 - P_{j+1}^{N_a}} + \sqrt{P_{j+1}^{N_a}}}$$

wherein $P_{j+1}^{N_a}$ is the estimation of P_j from the previous bit-plane.

9. The method according to claim 1, further comprising the following steps:

5 determining an optimal bit-plane from the plurality of constructed bit-planes;

determining a probability assignment to each bit-plane based on its relation to the optimal bit-plane;

- 10 wherein the probability assignment to the bit-plane is used as the statistical model for encoding the binary string of bit-plane symbols.

- 15 10. The method according to claim 9, wherein the optimal bit-plane is determined by determining an integer which best satisfies

$$\phi^{2^{L-1}} \leq \theta < \phi^{2^L}$$

- 20 wherein

L is the integer representing the optimal bit-plane,

ϕ is defined by $\left(\frac{\sqrt{5}-1}{2}\right)$,

θ is defined as

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$$\theta = e^{\Delta \sqrt{\frac{2}{\sigma^2}}}$$

11. The method according to claim 10, wherein the probability assignment the bit-plane is determined by

$$Q_j^L = \begin{cases} \frac{1}{1+2^{2^{j-L}}}, j \geq L \\ \frac{1}{2}, j < L \end{cases}$$

wherein

Q_j^L is the probability assignment of the j^{th} bit-plane.

12. The method according to claim 10, wherein the probability assignment to the bit-plane is determined by

$$Q_j^L = \begin{cases} \frac{1}{2^{2^{j-L}}}, j \geq L \\ \frac{1}{2}, j < L \end{cases}$$

wherein

Q_j^L is the probability assignment of the j^{th} bit-plane.

13. The method according to claims 5 or 7, further comprising the following steps:

decoding the encoded binary string of bit-plane symbols using a further statistical model to generate a further binary string of bit-plane symbols,

re-constructing a plurality of bit-planes comprising the bit-plane symbols using the further binary string of bit-plane symbols, wherein the further statistical model

is based on statistical properties of a Laplacian probability distribution function which characterizes the bit-plane symbols of the reconstructed bit-planes.

- 5 14. The method according to claim 13, wherein the data source is re-constructed from the bit-planes by

$$\hat{x}_i = (2s_i - 1) \left(\sum_{j=M-1}^T b_{i,j} 2^j + \sum_{j=T}^{\infty} P_j 2^j \right),$$

10 wherein

\hat{x}_i is the re-constructed data source,

s_i is a sign symbol of \hat{x}_i ,

$b_{i,j}$ is the bit-plane symbol, and

15 T is the bit-plane the encoded binary string of bit-plane symbols is terminated.

15. The method according to claims 11 or 12, further comprising the following steps:

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decoding the encoded binary string of bit-plane symbols using a further statistical model to generate a further binary string of bit-plane symbols,

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re-constructing a plurality of bit-planes comprising the bit-plane symbols using the further binary string of bit-plane symbols, wherein the further statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the bit-plane symbols of the reconstructed bit-planes.

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16. The method according to claim 15, wherein the data source is re-constructed from the bit-planes by

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$$\hat{x}_i = (2s_i - 1) \left(\sum_{j=M-1}^T b_{i,j} 2^j + \sum_{j=T-1}^{\infty} Q_j^i 2^j \right)$$

wherein

\hat{x}_i is the re-constructed data source,

10 s_i is a sign symbol of \hat{x}_i ,

$b_{i,j}$ is the bit-plane symbol, and

T is the bit-plane the encoded binary string of bit-plane symbols is terminated.

15 17. A device for processing bit symbols generated by a data source, in particular a video, still image or audio source, comprising:

20 a bit-plane construction unit for constructing a plurality of bit-planes from the data source, each bit-plane comprising a plurality of bit-plane symbols, and scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols,

25 a statistical model unit for providing statistical information based on statistical properties of a Laplacian probability distribution function which characterizes the data source, wherein the Laplacian probability distribution function is defined by

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$$f(x) = \frac{e^{-|x|\sqrt{\frac{2}{\sigma^2}}}}{\sqrt{2\sigma^2}}$$

wherein σ is the standard deviation of the Laplacian probability distribution function and

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an encoding unit for encoding the binary string of bit-plane symbols based on the statistical information provided by the statistical model unit.

10 18. A computer readable medium, having a program recorded thereon, wherein the program is to make the computer execute a procedure for processing bit symbols by a data source, comprising the following steps:

15 constructing a plurality of bit-planes using the bit symbols generated by the data source, each bit-plane comprising a plurality of bit-plane symbols;

20 scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols;

25 encoding the binary string of the bit-plane symbols using a statistical model, wherein the statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the data source, wherein the Laplacian probability distribution function is defined by

$$f(x) = \frac{e^{-|x|\sqrt{\frac{2}{\sigma^2}}}}{\sqrt{2\sigma^2}}$$

wherein σ is the standard deviation of the Laplacian probability distribution function.

- 5 19. A computer program element which is to make the computer execute a procedure for processing bit symbols generated by a data source, comprising the following steps:

10 constructing a plurality of bit-planes using the bit symbols generated by the data source, each bit-plane comprising a plurality of bit-plane symbols;

scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols;

15 encoding the binary string of the bit-plane symbols using a statistical model, wherein the statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes
20 the data source, wherein the data source has a form of a Laplacian probability distribution function, wherein the Laplacian probability distribution function is defined by

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$$f(x) = \frac{e^{-|x|\sqrt{\frac{2}{\sigma^2}}}}{\sqrt{2\sigma^2}}$$

wherein σ is the standard deviation of the Laplacian probability distribution function.